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ABSTRACT

This unit, developed by the Third World Science Project, is designed to add a multicultural element to existing science syllabi (for students aged 11-16) in the United Kingdom. The project seeks to develop an appreciation of the: boundless fascination of the natural world; knowledge, skills, and expertise possessed by men/women everywhere; application of knowledge and skills to solve the practical problems of everyday life; impact of modern technology in the world; and the influence of the cultural background on the perception of knowledge, problems, and solutions. The unit begins with historical background information on the ritualistic use of chewing-sticks, describing the most common plants that were chosen for this purpose. This is followed by brief discussions of chewing-sponges (to show differences in the technique employed) and the anti-bacterial activity in chewing-sticks, and a short list of references on chewing-sticks and sponges. The unit concludes with five class activities dealing with identification of different types of teeth, effect of acid on teeth, testing toothpaste, and finding some useful components of toothpaste. (JN)

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DENTAL CARE

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THIRD WORLD SCIENCE

Third World Science seeks to develop an appreciation of:

1 The boundless fascination of the natural world

2 The knowledge, skills and expertise possessed by men and women everywhere

3 The application of knowledge, skills and expertise to solve the practical problems of everyday life

4 The impact of modern technology in the third world

5 The influence of the cultural background on the perception of knowledge, problems and solutions

The following Units have been designed to fit into existing science syllabuses in the United Kingdom:

CARRYING LOADS ON HEADS: CHARCOAL: CLAY POTS:
DENTAL CARE: DISTILLATION: ENERGY CONVERTORS:
FERMENTATION: HOUSING: IRON SMELTING: METHANE DIGESTORS:
NATURAL DYES: PLANTS AND MEDICINES: SALT: SOAP.

The method of use is not closely prescribed. As resources teachers may use them in different ways though suggestions are offered. Feedback is invited from teachers concerning (a) the use made of the material (b) pupils reactions, if possible in their own words, and (c) suggestions for improvements, additions etc.

Please send feedback, ideas and requests to:

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DENTAL CARE

Teacher's Notes

The unit begins with a historical background on the ritualistic use of chewing-sticks and describes the most common plants that were chosen for this purpose. It appears that toothbrushing is introduced during formal schooling, especially in urban areas, and it is often considered a status symbol to use only the toothbrush and toothpaste. Nevertheless, it is becoming evident that the use of certain chewing-stick species may prevent tooth decay due to the anti-cariogenic substances they possess. This is followed by a brief section on chewing-sponges for teeth cleaning to show the differences in the technique employed. The section concludes with a reference to the anti-bacterial activity in chewing-sticks.

In the section on class activity we have introduced some practical work dealing with the identification of the different types of teeth, the effect of acid on teeth, testing toothpaste, and finding some useful components of toothpaste.

DENTAL CARE

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(i) Tooth Types
(ii) Tooth Structure
(iii) Tooth Decay - its causes and prevention
(iv) Testing Toothpaste
(v) To find useful components of toothpaste

THE HISTORICAL BACKGROUND OF THE USE OF CHEWING-STICKS

The use of plants has been intimately associated with dental hygienic and therapeutic practices since time immemorial. Since antiquity, many cultures of the world have utilized the chewing-stick as a means of teeth cleaning. The practice was known among the ancient Babylonians, Egyptians and Jews and was common among people of the Greek, Roman and Islamic empires. Reference to the sticks (*siwak*) that were frayed at one end by chewing or tapping and used for teeth cleaning can be found as far back as the 8th and 9th century in the Arabian works of Kitaf al Bajan by Gahiz. It is believed that the counterpart of the modern-day toothbrush utilizing animal bristles was unknown in Europe until about 300 years ago. However, in spite of the widespread conception of teeth cleaning by the toothbrush and toothpaste, the habit of using a chewing-stick for this purpose has not disappeared and is still practised throughout parts of Asia, Africa, the Middle East and the Americas. The reasons for the survival of the tooth-cleaning technique are as varied as the cultures in which it is still practised.

Although it appears that the use of chewing-sticks may have evolved in various cultures independent of each other, the influence of Islam on the spread and use of chewing-sticks in different parts of the world is significant. The reason for this can be traced to the prophet Muhammed, who has been quoted as saying: "*you shall clean your mouth, for this is a means of praising Allah, the siwak is an implement for the cleansing of teeth and a pleasure to Allah,*" *and "I am ordered (by Allah) to use the siwak so that I take it as if it has been written down for me (as a special commandment)*". The belief of the prophet regarding good oral hygiene was so profound that he requested one of his wives to prepare his *siwak* on his deathbed. In that day, and for several centuries thereafter, many attributeswere given to the use of the *siwak*, including making the teeth white and fragrant, strengthening and giving vigour to the gums and teeth as well as cleaning the mind, increasing the memory, quenching the bile, drying the phlegm, sharpening the eyes, stimulating the appetite, relieving constipation and increasing the ability to do good.

Custom also dictated how and when the *siwak* should be used and those who wished to practise the habit elegantly were advised to do so privately. They were deterred from using the chewing-stick in public places or on the street, when speaking, while standing or leaning against something, or in bed. Users were encouraged, however, to use the *siwak* on arising before breakfast, at noon when the stomach is empty, and before bedtime. It was also expected that people would clean their teeth before prayer, a habit that still can be

observed five times a day in some mosques. To the more orthodox Muslim, the use of the chewing-stick is still an important part of his ritual of worship.

Such ritualistic chewing-stick use can still be observed in mosques of Mandalay, Burma. Fresh sticks from Neem trees (*Azadirachta indica*) are available at the mosque for teeth cleaning before prayer and are then set apart for use over a 2-week period before discarding. Individuals carrying out this procedure will also clean their teeth by toothbrushing but will do so at home, for toothbrushing is usual in Burma. The practice of chewing-stick use however, is unknown to the botanists and the dentists of the capital Rangoon, who are primarily Buddist. Elsewhere in this part of Asia, the practice of ritualistic chewing-stick use has all but disappeared, although as recent as 1970 it was still being practised in the mosques of Penang, Malaysia.

The replacement of the chewing-stick for teeth cleaning with the toothbrush by many modern Muslims is not just related to improved economic conditions; in addition, synthetic toothbrush bristles have replaced those of animals (pig) origin. Therefore, only remnants of chewing-stick use remain in urbanized Muslim societies although the habit may still be observed in rural, less developed areas.

Among certain peoples or tribes, other types of teeth cleaning may also prevail. For example, Bedouin men prefer using the *siwak* while Bedouin women consider it more feminine to clean their teeth by chewing gum arabic, a resinous material from *Acacia senegal*, or mastic gum from *Pistacia lentiscus*. The Hausa of northern Nigeria prefer charcoal applied with the finger to chewing-stick use.

Within these Islamic countries the most common plant to be used as a '*siwak*' is *Salvadora persica*. This species and another, *Salvadora oleoides*, are succulent shrubs that grow throughout the arid regions of East Africa, the Middle East and eastward to Western India. Twigs from these plants are especially suited for teeth-cleaning purposes as the wood is spongy and fibrous and easily crushed between the teeth, or softened if dry, by water. It is unlikely that the chewing-stick simply cleans the teeth by mechanical removal of plaque alone, as the plant also possesses many medical substances that are purported to whiten the teeth, protect them from decay, remove the "tartar" as well as stimulate the gingiva and heal spongy and bleeding gums. Nowadays, for the devout, but more westernised Muslim, extracts of *Salvadora* have been incorporated into a commercially available toothpaste known as "Sarakan".

When *Salvadora* species are unavailable, other plants peculiar to the region may be substituted e.g. twigs from the olive tree (*Olea europaea*), several *Acacia* species and the *Neem* tree (*Azadirachta indica*) of Asia. It is also not uncommon for others to use the fibres of sugar cane or the stalk (*peduncle*) of the date palm.

Usually, children learn to use the *siwak* at about 6 years of age from their parents and siblings and will continue to do so unless they are introduced to toothbrushing during their formal schooling. Sometimes, in the Middle East, a black sandy material called '*turpa*' that contains carbonate is used as a dentrifice along with the chewing-stick. The effect of chewing-stick use on the dental health of these people has yet to be determined, and may become increasingly difficult as the habit declines in the more accessible regions.

The chewing-stick is still commonly used among many tribes of Sub-Sahara Africa and is especially well known among individuals living in rural communities. The chewing-sticks are fashioned from twigs, wood, or roots into pencil-sized pieces and chewing-sponges are prepared from the pounded fibre of branches and vines. Those that are most popular are either fibrous or soft in texture, sweet in taste, and considered to clean the teeth efficiently and enhance the health of the gums. Parental and group influence is signifcant in the choice of the bitter hard *Garcinia kola* that is preferred by men. Women usually prefer softer, more fibrous and sweeter woods and select plant species for their children with similar properties e.g. *Acacia* and *Terminalia* species used for sponges.

In West Africa, it is usually uncommon for introduced plant species to be adopted by practising herbalists for medicinal purposes as these persons are traditionally bound to the use of plants prescribed by their forefathers. However, this has not been the case with the *Neem* tree that was introduced by the British into West Africa over 50 years ago to prevent the use of trees such as ebony for firewood. The tree has become widespread and has been readily adopted by the Hausa in Nigeria as their most popular chewing-stick. The need for chewing hard substances among West Africans may be very real as the typical diet of meat stew and soft carbohydrate accompaniments in the form of rice, steamed fermented ground corn or pounded cassava root affords little opportunity to chew. In these societies, perhaps the prolonged sucking and chewing after cleaning serves as exercise and stimulate the gums and jaws as does chewing-gum or toothpicks. Whether extraction of any active medicinal ingredients takes place during this process and what effect it has on overall health of an individual remains unknown.

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Among the West Africans, concern for maintaining a white, shiny appearance to the teeth is as culturally important as is the absence of body odour among North Americans. Chewing-sticks use is taught meticulously by mothers and other family members to children at the time their permanent teeth begin to erupt. Before then there is usually little regard for the child's oral hygiene, which is reflected in the higher caries rates seen among this age group. The selection of chewing-sticks species for children vary with the tribe, with the Ashanti of Ghana preferring the soft, fibrous shoots of plantain and banana (*Musa*), the foaming chewing-sponges. Usually children's chewing-sticks are soft, fibrous and sweet to taste, whereas adults may select others that are somewhat harder or bitter in flavour.

The technique used involves first peeling the bark and then fraying the end by chewing or pounding. The teeth are cleaned by a thorough up-and-down motion, with care being taken to include both the buccal and lingual surfaces. Depending on the type of fibres employed, some may also penetrate the inter-proximal spaces. Throughout the procedure the mouth is rinsed several times so that the loose wood fragments can be got rid of.

Often after the cleaning procedure is complete, the chewing-stick is sucked for several hours. However, toothbrushing is introduced during formal schooling, especially in urban areas, and to the young intelligentsia of college age it is often considered a status symbol to use only the toothbrush and toothpaste. With others, the choice of teeth-cleaning method may be directly related to economics.

Although western influence is strong in the Asian countries of Pakistan, Nepal and India, teeth cleaning by means of the chewing-stick is still carried out. As toothbrushing with toothpaste is costly, toothbrushing without the use of commercial toothpaste has also been observed. Whenever the chewing-stick is used, not only are the teeth cleaner but so is the tongue. This procedure is carried out after teeth cleaning by splitting the stick into two and breaking it again in the middle so that it is hinged like a V; this is then stroked across the tongue several times to remove plaque (See diagram).

Tongue Cleaning With Chewing-stick.

The most popular species used in India, Pakistan, and Nepal is the *Neem* tree, where it is a popular shade tree growing along roadsides and in back-yards. The oil of the tree has great medicinal value as it is antibacterial, anti-inflammatory, and has healing properties. Substances from the *Neem* tree have been placed into a commercial dentrifice in India known as Neem toothpaste, and into toothpowders in Pakistan, called Neemodent.

In isolated communities of Appalachia, the Ozarks, The West Indies and Central America, chewing-sticks are still used or have been within the memory of the older members of the communities. It is known from early 19th century writings that the *Dogwood (Cornus florida)* was used for many dental purposes. The use of *Dogwood* is still known in Appalachia as is *black gum (Nyssa sylvatica), willow, and black birch.* In the West Indies, the *vine Gouania lupuloides* is still used, especially by people of African ancestry. On chewing, the vine produces foam, not unlike the chewing-sponges of Ghana.

Concurrent with the use of chewing-sticks, other "natural" types of teeth-cleaning procedures have been devised that include the use of foamy chewing-sponges, cleaning gums, and astringent fruits. The application of charcoal or salt with the finger or chewing-stick, to remove plaque, is also known in Africa and Asia.

Whenever possible, Western-trained dentists conscientiously introduce toothbrushing techniques to children of school age without having first evaluated the cheaper, traditional methods available. This can result in an ambivalent population that will discard the old ways and adopt the use of the toothbrush but cannot afford the toothpaste!

It is presently premature to estimate the impact of chewing-sticks use and other methods on dental health. However, it is becoming evident that the use of certain chewing-stick species may prevent tooth decay due to the anti-cariogenic substances they possess.

Chewing-Sponges for Teeth Cleaning

Chewing-sponges are preferred to chewing-sticks by many individuals who live in equatorial West Africa and their descendants in the West Indies and tropical America. The plants that are used have been selected for their fibrous texture, sweetness of taste, and the foam that can be extracted when chewed.

Plants selected for this purpose may be utilized in the natural state or prepared as sponges. In Ghana, certain villages specialise in preparing chewing-sponges from the branches or lianes (*vines*) of *Acacia species* for marketing throughout the southern part of the country.

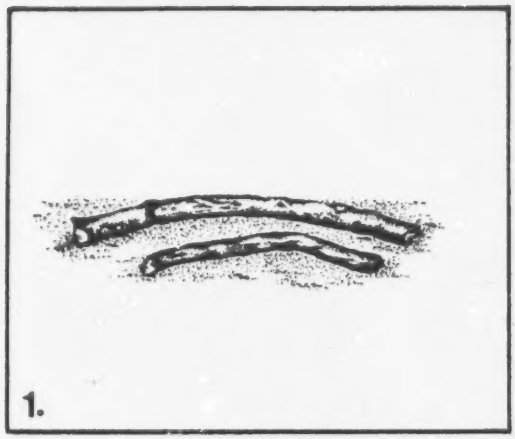
Branches and vines are collected in metre lengths (*Fig.1*) and are scorched to remove the bark and split lengthwise (*Fig 2*), beaten on rocks to release the interior fibres (*Fig 3*), washed to make the fibres more pliable and formed into straw-like sponges (*Figs 4 and 5*).

The technique of teeth cleaning with the chewing-sponge differs somewhat from that of the chewing-stick. The plant fibre that is used is either prepared as required or taken from the larger sponges in bite-sized portions. This fibre softens when chewed and also releases a foaming substance that causes increased expectoration during the cleaning period. During this period of chewing, which can last for 20 minutes, the mouth is also frequently rinsed with water. The teeth-cleaning procedure is then completed by passing the chewed material over the teeth and gums. The astringent properties of the chewing-sponge will also leave the mouth feeling clean and refreshed.

STAGES IN THE PREPARATION

OF

CHEWING SPONGES.



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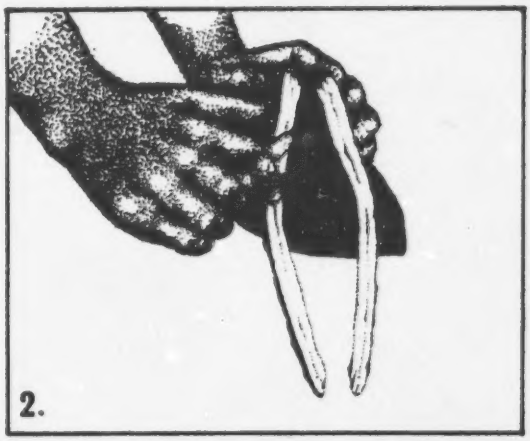

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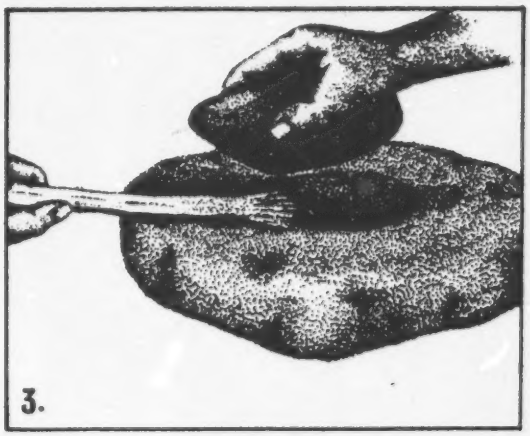

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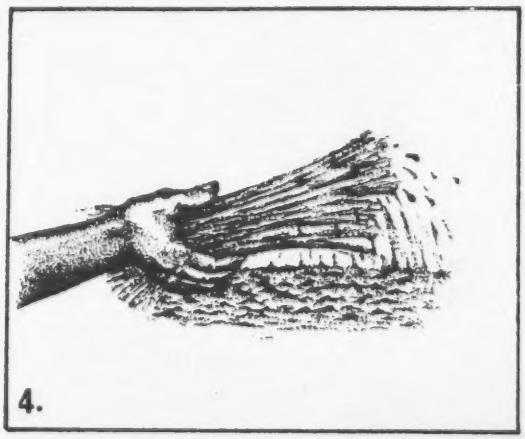

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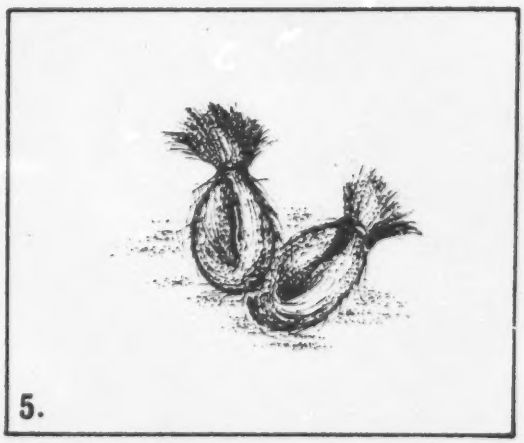

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The Antibacterial Activity in Chewing Sticks

The observations that African people generally have caries free teeth was borne out by the findings of a survey on dental health of 80 African students at N.E. London Polytechnic in 1977. Both Africans and Asians traditionally use chewing-sticks either in a deliberate teeth cleaning procedure or for longer periods of casual chewing. This widespread and ancient practice of using chewing-sticks as the only method for cleaning the teeth for millions of people, prompted an investigation to determine whether these sticks contained anti-bacterial compounds against oral streptococci including cariogenic species.

The investigation showed that there are other factors relevant to dental health, such as diet, socio-economics facts, sunlight, fluoride levels in water, heredity and linked combinations of these. Diet in poor African tribal communities usually consist basically of roots and cereals. It was found that this dietary starch was a poor substance for establishment of plaque and metabolism of cariogenic bacteria. The low caries prevalance among peasants was attributed to this dietary factor; fluoride levels in local water were low. The higher caries prevalence found in more affluent city dwellers was also attributed to their diet which included imported low molecular weight carbohydrate e.g. sucrose, which is a good substitute for the plaque forming bacteria.

From a small pilot survey in which 80 Asian and African students were asked about their dental health, diet and use of chewing-sticks, indications emerged that the use of sticks and original Asian and African diet were usually linked as part of a traditional lifestyle. Students in this group reported far healthier teeth than those who did not use sticks and had European diets. Possibly this combination of traditional diet and use of sticks is relevant to dental health.

A variety of simple and complex phenolics occur in plant tissues, which play a part as plant antiseptics, protecting the plant from disease. It is therefore reasonable to suggest that some of the phenolics may be relevant in chewing-sticks as antibacterial agents against cariogenic streptococci.

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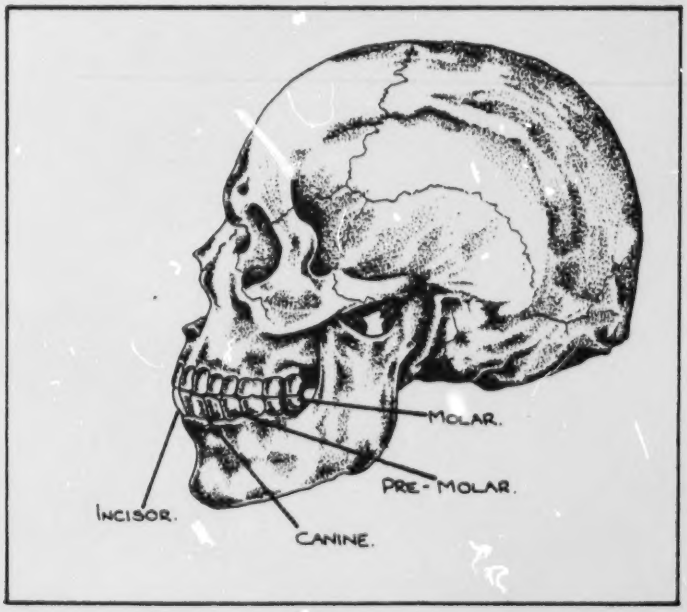
CLASS ACTIVITY

Tooth Types

Examine the teeth in your mouth by feeling them with your fingers and tongue. You will realise that they are of different shapes and sizes. Why is this? Carry out the following simple investigation to answer this question.

Experiment 1

Eat an apple and say which teeth you used to (i) bite the apple, (ii) chew the apple. Next bite off a small piece from a bar of toffee and chew it. Say whether you used the same teeth to bite the toffee as you did to bite the apple.



Side view of human skull.

Study the above diagram and you will see that you used your *incisors* or front teeth to bite the apple, and the *canines* or more pointed teeth to tear a piece from the bar of toffee. You chewed both with the large double teeth or *molars* at the back of the mouth. From the above digram you will see that the *molars* have been split into two groups; the back three on each side are called *molars*, the teeth between them and the *canines* are called *pre-molars*. Count the number of *molars* in the diagram; how many *molars* do you have?

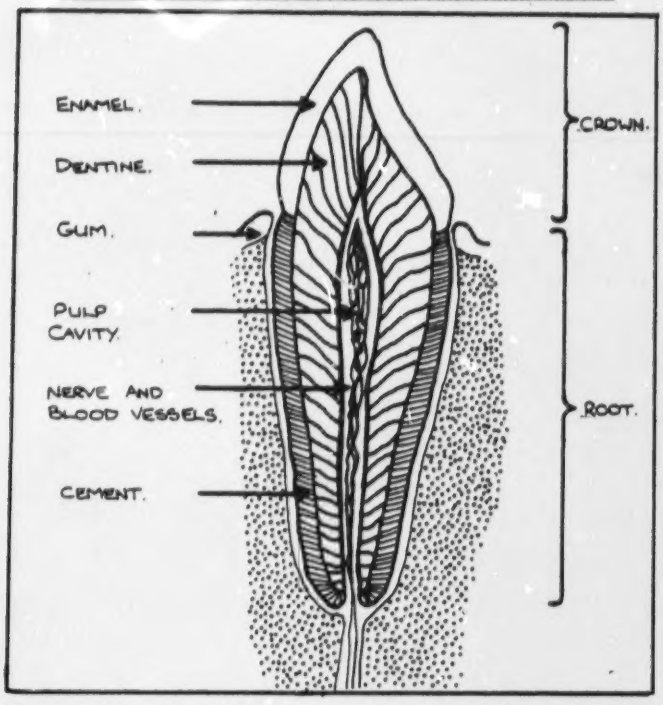
in the diagram? How many *molars* do *you* have?

The number and different kinds of teeth possessed by an animal constitute its *dentition*. Just as in Chemistry, where it is useful to summarise information by means of chemical formulae, the dentition of a mammal can be represented by a *dental formula*. Here are two ways of writing down the dental formula for an adult man.

$$\text{i } \frac{2}{2} : \text{c } \frac{1}{1} : \text{pm } \frac{2}{2} : \text{m } \frac{3}{3} \text{ or simply } \frac{2\ 1\ 2\ 3}{2\ 1\ 2\ 3}$$

Tooth Structure

Vertical Section of Human Incisor Tooth



Each tooth consists mainly of a bone-like material called *dentine*. The crown of the tooth is protected by a very hard substance called *enamel*, and the root is covered by a layer of *cement*. The pulp cavity in the middle of the tooth contains nerves and blood vessels.

Care of Teeth

Our teeth, although very important to us, are often neglected and abused. Are all your teeth in perfect condition, or have some had to be filled or extracted? Make a survey of your class and for each pupil find the number of teeth that have fillings in them and the number that have been extracted. How many pupils in your class have got perfect teeth? Use your results to construct a histogram.

The causes and prevention of tooth decay

Experiment 1

1. Examine a tooth which has been extracted from any mammal e.g.human or sheep, and prod it with a forceps or the sharp point of a needle. If the tooth is hard, then it is in good condition.

2. Allow the tooth to soak in dilute hydrochloric acid for 2 or 3 days.

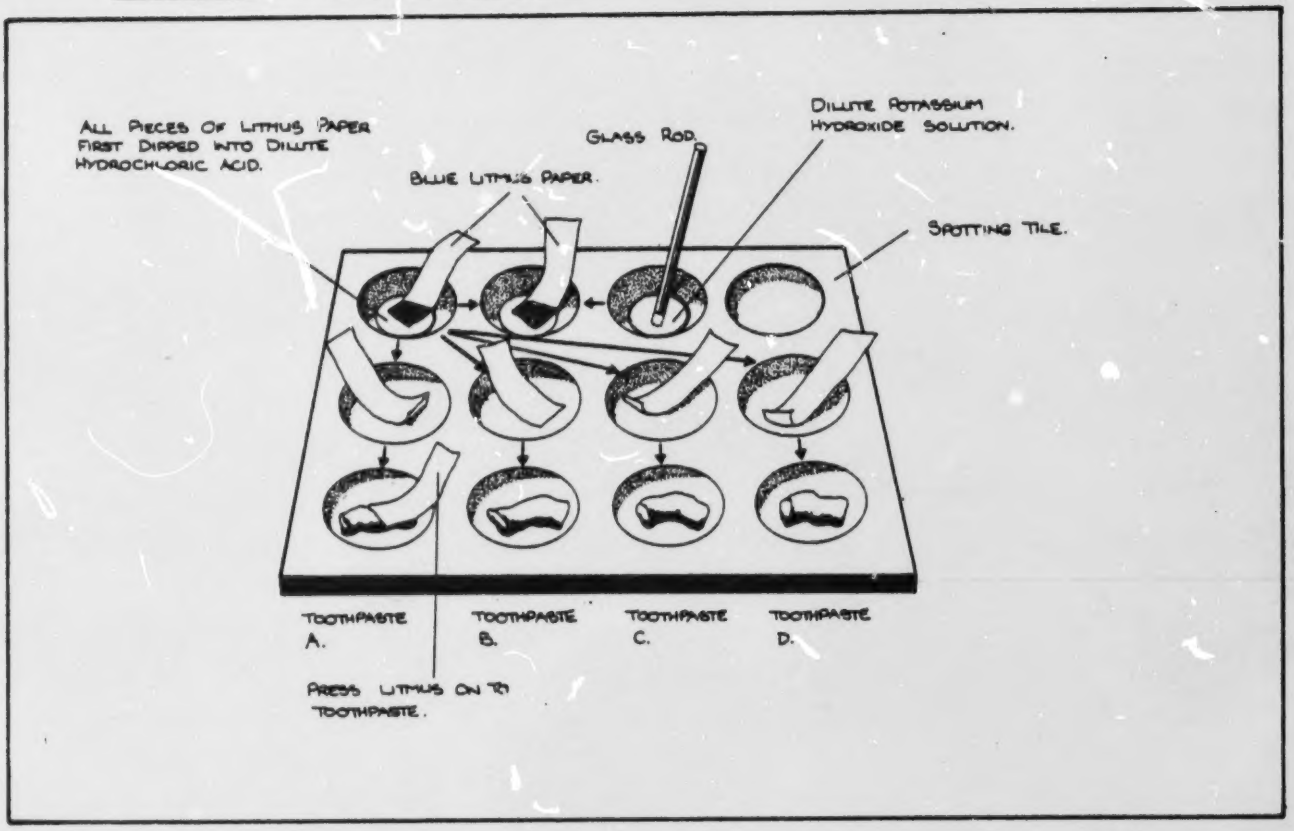
3. Rinse the tooth carefully and examine it by prodding with the forceps. What affects have the acid had on the tooth?

You will probably discover that the tooth begins to get eaten away where the enamel has been removed. You may even see bubbles of gas coming from the tooth. What is the gas? If the acid is strong enough or if the tooth is left long enough in it, you will find that the enamel is eventually destroyed and the tooth will crumble away if prodded.

After a meal, food particles invariably become lodged between the teeth, and if they remain there, bacteria in the mouth feed on them and multiply, breaking down the foodstuffs and liberating acids. These acids will then attack the teeth more slowly than the hydrochloric acid - but just as surely.

We can prevent tooth decay by doing two things viz: remove the cause of decay and strengthen the teeth. We can reduce the formation of acid by brushing the teeth, so that particles of food can be dislodged and so helping to remove bacteria from the teeth. How does toothpaste help in fighting tooth decay? Follow experiments 3 and 4 to answer the last question.

Experiment 3 - Testing Toothpaste



1. Use a spotting tile as in the above diagram and place a few drops of dilute hydrochloric acid in the first 'well'.
2. Next dip the end of a strip of blue litmus paper into the acid and then place it in the next well.
3. Then place a few drops of dilute potassium hydroxide solution in the third well, and by means of a glass rod transfer the alkali, a drop at a time, on to the wet end of the litmus paper. Observe and note any colour change.
4. Dip another 4 strips of blue litmus paper into the acid and arrange one on each well in the second row, (See diagram).
5. Squeeze about 1 cm length of toothpaste on to the first well on the third row.
6. Transfer a strip of litmus paper from row 2 to the toothpaste and press. Note the time for any colour change to occur.
7. This test can be repeated by using different brands of toothpaste.

Study the results of your investigations and decide what effect toothpaste has on acid. Could this reaction help in preventing tooth decay?

Blue litmus paper turns red in acid, but changes back to blue as the potassium hydroxide reacts with it, that is, neutralises the acid. The potassium hydroxide is an alkali, and you may find that some of the toothpastes are also alkaline. They thus neutralise the acid, though you probably found that they took much longer to do so. Some toothpastes may not be alkaline at all. When you consider the short time that the paste is in contact with the teeth before being rinsed away, you will realize that there is not enough time for much chemical reaction to take place.

Experiment 4 - To find whether toothpaste has any other useful ingredients

1. Half fill a clean test tube with distilled water and squeeze into it a 2 cm length of toothpaste.
2. Shake well for about 2 minutes.
3. Place a drop of the liquid on a slide and examine under the low power of the microscope.
4. Allow the test tube to stand for 5 minutes and examine the liquid.

Masses of particles which do not dissolve in water will be clearly visible under the low power of the microscope. These particles hang in suspension in the water and will eventually sink as a sediment to the bottom of the test tube. These minute particles help to remove from the teeth the surface scum which contains the harmful bacteria. The powder is said to be abrasive. Sinks and bathtubs are cleaned with similar powder with much larger particles -- such large particles would damage teeth.

Some brands of toothpaste claim to contain components which kill bacteria, but, as with neutralisation, the toothpaste does not usually remain in the mouth long enough to be really effective. Therefore it seems that the most significant part of the process of cleaning the teeth is the actual brushing, which deals physically rather than chemically with the bacteria and food particles.

Fluoridation

Drinking water comes mainly from rainfall and contains dissolved gases such as carbon dioxide and also varying concentrations of mineral salts, depending on the nature of the ground over which the water flows on its way to the reservoir. Calcium fluoride is one of the salts found naturally in the drinking water of some towns.

For many years scientists have been aware of the fact that people living

in towns where there were traces of fluoride in the water suffered less from dental caries than those whose water supply did not contain any.

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Graphics: George Robinson

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Writers: Natalie Jones, Wyn Hughes Typing: Marjorie Eccles
Graphics: Karen Moss

In this phase of the project 100 sets of 14 Units have been produced and distributed to schools, teachers' centres and teacher training establishments. Draft material has been prepared for further Units.

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